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Description

Technical Field

This invention relates to a valve assembly for determining air flow to an internal combustion engine and to a method of machining a valve bore for such a valve assembly.

Background

Electronic control of an automotive internal combustion engine frequently requires measurement or calculation of the air flow to the engine. For many engines, such air flow is determined by a rotatable valve disposed in the engine air induction passage. In some applications the valve is a throttle valve which is positioned by an operator to determine or control air flow to the engine. In other applications the valve is an air valve the position of which is regulated to determine or measure air flow to the engine. With either type of valve, air flow to the engine varies as a function of the air flow area around the valve and the pressure difference across the valve.

Because the air flow area around such a valve is geometrically related to the position of the valve, valve position is often sensed as a basis for measuring or calculating air flow to the engine. In a conventional induction air flow valve assembly, however, the change in the air flow area around the valve for a selected rotation of the valve is much greater when the valve is near its minimum air flow position than when the valve is near its maximum air flow position, and calibration of the valve position sensor is thereby complicated. Structures which would offer a relatively low normalized change in the air flow area around the valve have required manufacturing techniques which, at least in some cases, have not been compatible with the flat butterfly valve conventionally used to determine air flow to internal combustion engines.

Summary of the Invention

This invention provides a valve assembly which offers a relatively low normalized change in the air flow area around a flat butterfly valve and which may be simply manufactured. This invention further provides a method of machining a valve bore for such a valve assembly.

In a valve assembly according to this invention, a flat butterfly valve is disposed on a shaft in a circular induction passage bore which has two undercut recesses located on opposite sides of the valve shaft; the portions of the bore that are upstream and downstream of the valve shaft are concentric with one another, and the butterfly valve has a peripheral configuration substantially defined by the intersection of a right circular cylinder and a plane which is oblique with respect to a plane perpendicular to the cylinder axis; each of the recesses has a radius in a plane perpendicular to the axis of the bore substantially equal to the radius of the bore, and each of the recesses has a radius in a plane through the axis of the bore exceeding the radius of the bore; one of the recesses has its deepest portion slightly upstream of the valve shaft, and the other of the recesses has its deepest portion slightly downstream of the valve shaft; the valve rotates in excess of 90° between a position providing a minimum air flow area around the valve and a position providing a maximum air flow area around the valve, and the valve assembly offers a relatively low normalized change in the air flow area around the valve. The valve determines air flow through the bore to the engine and may be used either as a throttle valve to control air flow to the engine or as an air valve to measure air flow to the engine.

The bore in such a valve assembly according to this invention is machined by a tool having a diameter substantially equal to the diameter of the bore and an arcuate cutting surface having a radius of curvature exceeding the radius of the bore. A suitable machining technique for forming the undercut recesses in the bore is disclosed in US—A—2 389 201. At one location along the bore, the machining tool is transversed laterally toward one side of the bore to form one of the undercut recesses in the bore, and at another location along the bore, the machining tool is transversed laterally toward the opposite side of the bore to form the other undercut recess in the bore.

The details as well as other features and advantages of a preferred embodiment of this invention are set forth in the remainder of the specification and are shown in the accompanying drawing.

Summary of the Drawing

Figure 1 is a sectional elevational view of a valve assembly made according to this invention showing the relationship of the valve and two undercut recesses in the valve bore;

Figure 2 is a top plan view of the Figure 1 assembly showing the undercut recesses with broken lines;

Figure 3 is an elevational view of a tool employed to machine the bore; and

Figure 4 is an end view of the tool shown in Figure 3.

The Preferred Embodiment

Referring to the drawing, a valve assembly 10 includes a valve body 12 having a circular bore 14 forming an induction passage for air flow to an internal combustion engine. A valve shaft 16 is mounted in body 12 and extends diametrically across bore 14. A flat butterfly valve 18 is secured to shaft 16. Valve 18 has a generally oblong peripheral configuration preferably defined by the intersection of a right circular cylinder and a plane which is oblique with respect to a plane perpendicular to the cylinder axis. Rotation of valve 18 and shaft 16 varies the air flow area around valve 18 to determine the air flow through bore 14.

Undercut recesses 20 and 22 are formed in bore 14 on opposite sides of shaft 16. Recesses 20 and 22 are formed by a machining tool 24 having a diameter D equal to the diameter of bore 14 and including a plurality of arcuate cutting edges 26

having a radius of curvature R exceeding the radius of bore 14. Machining tool 24 is inserted in bore 14 along the axis 28 and, at a location 30 along axis 28, is traversed laterally along a line 32 toward one side of bore 14 to form recess 20. At another location 34 along axis 28, machining tool 24 is traversed laterally along a line 36 toward the opposite side of bore 14 to machine recess 22.

Machining tool 24 thus forms undercut recesses 20 and 22 on opposite sides of shaft 16 with the deepest portion 38 of recess 20 being slightly upstream of shaft 16 and with the deepest portion 40 of recess 22 being slightly downstream of shaft 16. The radius of each of the recesses 20 and 22 in a plane perpendicular to axis 28 is substantially equal to the radius of bore 14, and the radius of recesses 20 and 22 in a plane through axis 28 exceeds the radius of bore 14.

Valve 18 extends into recesses 20 and 22 as shown in Figure 1 to establish a minimum air flow area around valve 18. As shown by the arcuate arrows 42, valve 18 rotates in excess of 90°, and preferably up to 105°—120°, between the position providing the minimum air flow area around valve 18 and a position providing a maximum air flow area around valve 18.

With this construction, rotation of shaft 16 and valve 18 offers a relatively low normalized change in the air flow area around valve 18. The normalized change in the air flow area around valve 18 may be expressed as $dA/Ad\theta$, where A represents the air flow area around valve 18, dA represents the change in the air flow area around valve 18, and $d\theta$ represents the rotation or change in position of shaft 16 and valve 18. We believe $dA/Ad\theta$ should be less than 0.06, and with this construction we have limited $dA/Ad\theta$ to no more than 0.048. We believe that $dA/Ad\theta$ could be optimized at a maximum of about 0.038.

As noted above, valve 18 may be employed as an operator-positioned throttle valve to control air flow through induction passage 14. In other applications, valve 18 may be employed as an air valve which is positioned to maintain a constant pressure difference across the valve and thereby provide a measure of the air flow through induction passage 14. In either application, the relatively low normalized change in the air flow area around valve 18 will permit simplified calibration of a valve position sensor intended for use in an electronic engine control system.

As shown in Figures 1—2, shaft 16 extends diametrically across bore 14. In some applications, however, the valve shaft does not extend diametrically across the valve bore but instead is offset toward one side of the bore. Such a structure requires flats on the edges of the valve adjacent the ends of the shaft to prevent binding of the valve in the bore, and the resulting gap between the flattened edges of the valve and the valve bore provides an air flow path which varies the relationship between the air flow area around the valve and the position of the valve. The diameter of the valve shaft may be enlarged to at least partially fill the gap, and it should be appreciated that the additional air flow area of recesses 20 and 22 included in the present construction allows enlargement of valve shaft 16 to fill such a gap without restricting the maximum flow area of bore 14.

Claims

1. A valve assembly (10) for determining air flow to an internal combustion engine, said assembly comprising a valve body (12) having a bore (14) forming an induction passage for air flow to the engine, said bore (14) having a generally circular cross section, a rotatable valve shaft (16) extending across said bore (14), and a flat butterfly valve member (18) secured to said shaft (16), said valve member (18) being rotatable with said shaft (16) for varying the air flow area about said valve member (18) to determine the air flow through said bore (14), said bore (14) having two undercut recesses (20, 22) located on opposite sides of said shaft (16), one (20) of said recesses having its deepest portion (38) slightly upstream of said shaft (16) and the other (22) of said recesses having its deepest portion (40) slightly downstream of said shaft (16), and said valve member (18) extending into said recesses (20, 22) to establish a minimum air flow area around said valve member (18), characterised in that the portions of the bore (14) that are upstream and downstream of said valve shaft are concentric with one another; said valve member (18) has a peripheral configuration substantially defined by the intersection of a right circular cylinder and a plane which is oblique with respect to a plane perpendicular to the cylinder axis; each of said recesses (20, 22) has a radius in a plane perpendicular to the axis (28) of said bore (14) that is substantially equal to the radius of said bore (14); each of said recesses (20, 22) has a radius (R) in a plane through the axis (28) of said bore (14) exceeding the radius of said bore (14); and said valve member (18) rotates in excess of 90° between the position providing the minimum air flow area around said valve member and a position providing a maximum air flow area around said valve member; so that, during rotation, said valve member (18) offers a relatively low change in the air flow area around said valve member (18).

2. A valve assembly according to claim 1, characterised in that the assembly is a throttle valve assembly (10) for controlling air flow to the internal combustion engine.

3. A valve assembly according to claim 1, characterised in that the assembly is an air valve assembly for measuring air flow to the internal combustion engine.

4. A method of making a valve assembly (10) according to claim 1, in which the method includes the steps of: inserting a machining tool (24) in said bore (14), said tool (24) having a diameter substantially equal to the diameter of said bore (14); at one location (30) along said bore (14), traversing said tool (24) laterally towards one

side of said bore (14) to form an undercut recess (20) in said bore; and, at another location (34) along said bore (14), traversing said tool (24) laterally towards the side of said bore (14) opposite said one side to form another undercut recess (22) in said bore; characterised in that said tool (24) includes an arcuate cutting edge (26) having a radius of curvature (R) exceeding the radius of said bore (14), and the undercut recesses (20, 22) are positioned either side of said rotatable shaft (16) with the radius of each of the recesses (20, 22) being substantially equal to the radius of the bore (14) in a plane perpendicular to the bore axis (28) and exceeding tha radius of the bore (14) in a plane extending through the bore axis (28), so that when the rotatable butterfly valve member (18) is disposed in said bore and extends into said recesses (20, 22), it can rotate in excess of 90° between the position providing the minimum flow area around said valve member and the position providing the maximum flow area around said valve member.

Patentansprüche

1. Ventilanordnung (10) zur Bestimmung von Luftströmung zu einer Brennkraftmaschine, wobei die Anordnung ein Ventilgehäuse (12) mit einer Bohrung (14) umfaßt, die einen Einführdurchlaß für Luftströmung zu der Maschine bildet, wobei die Bohrung (14) einen allgemein kreisförmigen Querschnitt besitzt, eine drehbare Ventilwelle (16) sich quer durch die Bohrung (14) erstreckt und ein flaches Klappenventilglied (18) an der Welle (16) befestigt ist, wobei das Ventilglied (18) mit der Welle (16) drehbar ist zum Verändern der Luftströmungsflächen um das Ventilglied (18) zur Bestimmung der Luftströmung durch die Bohrung (14), wobei die Bohrung (14) zwei eingeschnittene Vertiefungen (20, 22) besitzt, die an entgegengesetzt liegenden Seiten zur Welle (16) liegen, eine (20) der Vertiefungen ihren tiefsten Abschnitt (38) leicht in Zustromrichtung vor der Welle (16) und die andere (22) Vertiefung ihren tiefsten Abschnitt (40) leicht in Strömungsrichtung nach der Welle (16) besitzt, wobei das Ventilglied (18) sich in die Vertiefungen (20, 22) erstreckt, um eine Minimal-Luftströmungsfläche um das Ventilglied (18) zu bestimmen, dadurch gekennzeichnet, daß die Abschnitte der Bohrung (14), die in Strömungsrichtung vor und nach der Ventilwelle liegen, konzentrisch zueinander sind; daß das Ventilglied (18) eine Umfangsgestalt besitzt, die im wesentlichen durch eine Überschneidung eines geraden Kreiszylinders mit einer Ebene bestimmt ist, die bezüglich einer zur Zylinderachse senkrechten Ebene schief liegt; daß jeder Vertiefung (20, 22) einen Radius in einer zur Achse (28) der Bohrung (14) senkrechten Ebene besitzt, der im wesentlichen gleich dem Radius der Bohrung (14) ist; daß jede Vertiefung (20, 22) einen Radius (R) in einer Ebene durch die Achse (28) der Bohrung (14) besitzt, der den Radius der Bohrung (14) übertrifft; und daß das Ventilglied (18) zwischen der die minimale Luftströmungsfläche um das Ventilglied schaffenden Stellung und einer eine maximale Luftströmungsfläche um das Ventilglied schaffenden Fläche sich mehr als 90° dreht; so daß während der Drehung das Ventilglied (18) eine relativ geringe Änderung der Luftstromfläche um das Ventilglied (18) anbietet.

2. Ventilanordnung nach Anspruch 1, dadurch gekennzeichnet, daß die Anordnung eine Drosselventilanordnung (10) zum Steuern der Luftströmung zu der Brennkraftmaschine ist.

3. Ventilanordnung nach Anspruch 1, dadurch gekennzeichnet, daß die Anordnung eine Luftventilanordnung zum Messen von Luftströmung zur Brennkraftmaschine ist.

4. Verfahren zur Herstellung einer Ventilanordnung (10) nach Anspruch 1, wobei das Verfahren die Schritte enthält: Einsetzen eines Bearbeitungswerkzeuges (24) in die Bohrung (14), wobei das Werkzeug (24) einen im wesentlichen dem Durchmesser der Bohrung (14) gleichen Durchmesser besitzt; seitliches Verfahren des Werkzeuges (24) zu einer Seite der Bohrung (14) hin, an einer Stelle (30) längs der Bohrung (14), zur Bildung einer eingeschnittenen Vertiefung (20) in der Bohrung; und seitliches Verfahren des Werkzeuges (24) zu der der einen Seite gegenüberliegenden Seite der Bohrung an einer anderen Stelle (34) längs der Bohrung (14) zur Ausbildung einer anderen eingeschnittenen Vertiefung (22) in der Bohrung; dadurch gekennzeichnet, daß das Werkzeug (24) eine gekrümmte Schneidkante (26) mit einem Krümmungsradius (R) besitzt, der den Radius der Bohrung (14) übertrifft, und daß die eingeschnittenen Vertiefungen (20, 22) zu beiden Seiten der drehbaren Welle (16) angeordnet sind, wobei der Radius jeder Vertiefung (20, 22) in einer Ebene senkrecht zur Bohrungsachse (28) gleich dem Radius der Bohrung (14) ist und in einer sich durch die Bohrungsachse (28) erstreckenden Ebene den Radius der Bohrung (14) übertrifft, so daß, wenn das drehbare Klappenventilglied (18) in die Bohrung eingesetzt ist und sich in die Vertiefungen (20, 22) erstreckt, es sich mehr als 90° zwischen der Stellung, die die minimale Strömungsfläche um das Ventilglied schafft, und der Stellung, die die maximale Strömungsfläche um das Ventilglied schafft, drehen kann.

Revendications

1. Débitmètre à obturateur (10) destiné à établir le débit d'air se dirigeant vers un moteur à combustion interne, qui comprend un corps (12) où est ménagé un alésage (14) formant une conduite d'admission pour l'écoulement de l'air vers le moteur et présentant une section de forme générale circulaire, un arbre d'obturateur tournant (16) qui s'étend à travers cet alésage (14), et un obturateur papillon plat (18) fixé à l'arbre (16) et solidaire en rotation de ce dernier pour faire varier la section de passage d'air autour de l'obturateur (18) pour fixer le débit d'air s'écoulant dans l'alésage (14), qui est creusé de deux évidements en contre-dépouille (20, 22) placés de

part et d'autre de l'arbre (16) de manière que l'un (20) d'eux ait sa partie la plus profonde (18) en peu en amont de l'arbre (16) et l'autre (22), sa partie la plus profonde (40) un peu en aval de celui-ci et de manière que l'obturateur (18) pénètre dans ces évidements (20, 22) pour établir une section de passage d'air minimale autour de lui et qui est caractérisé en ce que les parties de l'alésage (14) qui se trouvent en amount et en aval de l'arbre sont coaxiales entre elles, en ce que l'obturateur (18) possède une configuration périphérique pratiquement définie par l'intersection d'un cylindre droit à base circulaire et d'un plan qui est oblique par rapport à un plan perpendiculaire à l'axe du cylindre; en ce que chacun de ces évidements (20, 22) possède un rayon mesuré dans un plan perpendiculaire à l'axe (28) de l'alésage (14) qui est égal au rayon de l'alésage (14); en ce que chacun de ces évidements (20, 22) possède un rayon (R) mesuré dans un plan qui passe par l'axe (28) de l'alésage (14), supérieur au rayon de l'alésage (14); et en ce que cet obturateur (18) bascule de plus de 90° entre la position qui établit la section de passage d'air minimale autour de l'obturateur et une position qui établit une section de passage d'air maximale autour de l'obturateur de sorte que, pendant sa rotation, l'obturateur (18) offre une variation relativement faible de la section de passage d'air autour de lui.

2. Débitmètre à obturateur selon la revendication 1, caractérisé en ce que le débitmètre est à obturateur papillon (10) pour commander l'écoulement d'air se dirigeant vers un moteur à combustion interne.

3. Débitmètre à obturateur selon la revendication 1, caractérisé en ce que le débitmètre est destiné à mesurer l'écoulement d'air se dirigeant vers un moteur à combustion interne.

4. Procédé de fabrication d'un débitmètre à obturateur (10) selon la revendication 1, qui comprend les phases consistant à introduire un outil d'usinage (24) dans l'alésage (14) qui présente un diamètre égal au diamètre de l'alésage (14); en un point (30) situé sur l'axe de l'alésage (14), déplacer l'outil (24) latéralement vers un premier côté de l'alésage (14) pour creuser un évidement en contre-dépouille (20) dans l'alésage et, en un autre point (34) de l'axe de l'alésage (14), déplacer cet outil (24) latéralement vers le côté de l'alésage (14) qui est à l'opposé de ce premier côté pour creuser un autre évidement en contre-dépouille (22) dans l'alésage, caractérisé en ce que cet outil (24) présente une arête de coupe courbe (26) ayant un rayon de courbure (R) supérieur au rayon de l'alésage (14), et en ce que les évidements en contre-dépouille (20, 22) sont positionnés sur les deux côtés de l'arbre tournant (16), le rayon de chacun des évidements (20, 22) étant égal au rayon de l'alésage (14) mesuré dans un plan perpendiculaire à l'axe (28) de l'alésage et étant supérieur au rayon de l'alésage (14) dans un plan qui passe par l'axe (28) de l'alésage, de sorte que, lorsque l'obturateur papillon (18) est placé dans cet alésage et pénètre dans ces évidements (20, 22), il peut tourner de plus de 90° entre la position qui établit la section de passage minimale autour de l'obturateur et la position qui établit la section de passage maximale autour de cet obturateur.

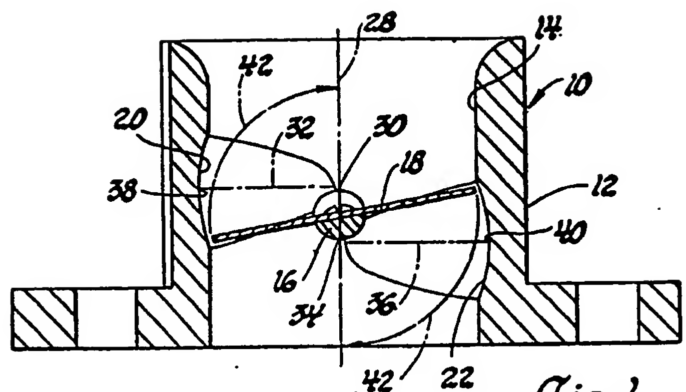

Fig.1

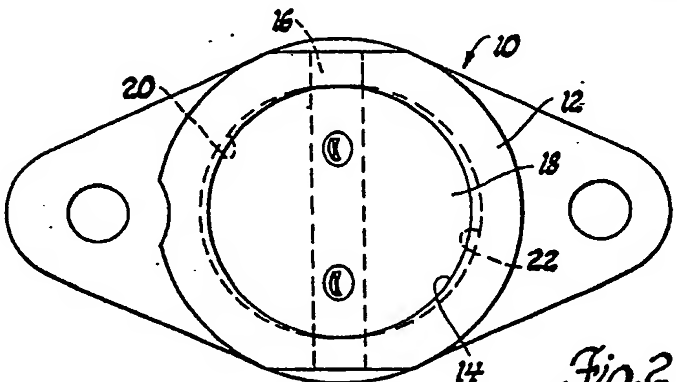

Fig.2

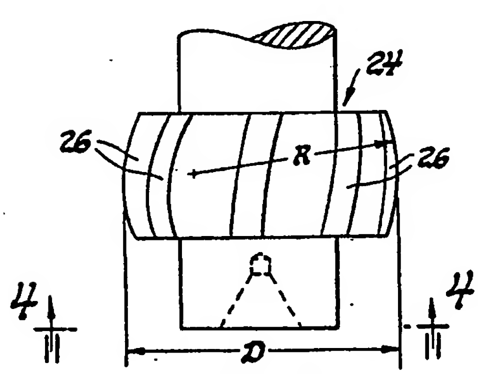

Fig.3

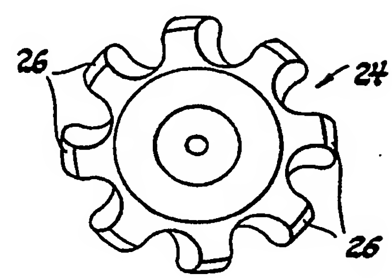

Fig.4